Summary of ICCR Source Work Group Meeting
April 30, 1998
Reciprocating Internal Combustion Engines WG Meeting

I. Purpose

The main objectives of the meeting were the following:

- Review goals, work activities, and membership of subgroups and ad-hoc groups
- Receive an update on testing issues, including draft work order for catalyst vendor and highlights of meeting with EPA testing contractor
- Receive an update on P2; including status of GCP Subgroup and any new recommendations from the CC
- Develop preliminary model engines for above-the-floor cost effectiveness estimates

II. Location and Date

The meeting was organized by the Environmental Protection Agency (EPA) and was held at the Engines and Energy Conversion Laboratory at Colorado State University in Fort Collins, Colorado. The meeting took place on April 30, 1998.

III. Attendees

Meeting attendees included representatives of the OAQPS Emission Standards Division, trade associations, universities, and state agencies. A complete list of attendees, with their affiliations, is included as Attachment I.

IV. Summary of Meeting

The meeting consisted of discussions between WG members on selected issues which are listed below. The order of the meeting followed the agenda provided in Attachment II. A bullet point summary of the meeting is presented as Attachment III.

The topics of discussion included the following:

- Report on CC Meeting
- Presentation and discussion of Population Subgroup’s

findings on the preliminary MACT floor for landfill and digester gas
- Update on pollution prevention activities
- Review of subgroups and ad-hoc groups
- Update on testing issues
- Presentation on cost calculations for add-on controls
- Presentation on cost/benefit analysis for above-the-floor MACT
- Presentation of strawman model engines and development of preliminary model engines
- Usage and size cutoffs for subcategorization
- SCR for HAP reduction
- Next meeting issues

Report on CC Meeting

Vick Newsom gave a brief synopsis of the April 28-29 CC Meeting. A copy of the CC Meeting flash minutes is available on the TTN.

- One important note is that EPA would like to consider the perspectives of CC and WG members in deciding whether to renew the FACA charter; the current charter expires September 16, 1998. [Since the meeting, EPA has determined that the charter was initially activated on September 6, 1997; therefore the charter will actually expire on September 6, 1998.] EPA indicated that CC and WG members will be contacted individually for their feedback. Jan Connery will be contacting members of the RICE WG by telephone in May to get feedback from the group.

Presentation and Discussion of Population Subgroup's Findings on the Preliminary MACT Floor for Landfill and Digester Gas

Brahim Richani made a presentation regarding the preliminary MACT floor for Landfill/Digester Gas. The data show that the MACT floor is "air injection" as an add-on control device. This presentation is included as Attachment IV. The discussion included the following topics:

- Ed Wheless of L.A. County Sanitation Districts and Ed Repa of NSWMA stated that the application of air injection as an add-on control device to landfill gas fired engines is unique; it was used to replace an NSCR catalyst which lasted for only a few days, and was meant to be a temporary fix.

This technology was primarily designed for NOx reduction. Ed Wheless indicated that the RICE Population Database is not representative of the total population of engines firing landfill or digester gas. He has a database of 350 engines firing these fuels located at 89 facilities. Ten of these engines are rich burn units. These are the same ten engines with the air injection technology identified in the RICE Population Database, They represent 2.8% of Ed Wheless' database, which does not reflect a floor. Ed Wheless will provide Alpha-Gamma with a copy of his database.

- Don Price stated that these engines are located in the Bay Area District, and according to the District, this engine control technology has not been very successful. These engines have had several violations. It is probable that the state will not permit any other sites to utilize this type of control technology.
- Jay Martin pointed out that the Small Engine business has looked into the air pump (air injection) as a control device for criteria pollutants (primarily NOx), and it has been demonstrated that this is not a successful control technique for these pollutants.
- Even though air injection may reduce HAPs, burning the fuel at ultra rich conditions would potentially increase HAPs initially, so the net result is essentially zero.
- These engines represent a special case, and achievability would be difficult to demonstrate.
- Bob Stachowicz mentioned that flaring, representing 2% of the controls for Landfill/Digester Gas, is not actually a control device for engines. Flaring is a separate control technology and is usually used in parallel, or as a backup, to an IC engine. These 2% will be relegated to the "nonsense" control category in the Population Database by Alpha-Gamma.
- Consensus for the preliminary MACT floor for the Landfill/Digester Gas subcategory is no add-on controls. Reasoning for this decision will be documented in the MACT Floor Rationale. Bryan Willson will compose an engineering summary to be included in the rationale explaining why this technology theoretically would not reduce HAPs.

Update on Pollution Prevention Activities

The general discussion included the following topics:

- Don Dowdall is currently working on a Good Combustion Practices Document. It is based on maintenance manuals provided by engine manufacturers. As soon as it is reviewed

by the Pollution Prevention Subgroup, Don Dowdall will forward it to the RICE WG.

- Don Price has provided examples of what state regulatory agencies require from engine operators regarding good operating practices to Don Dowdall. Don Dowdall will add this information to the Good Combustion Practices Document.
- Much of the suggested good combustion practices should be determined by the user, and should not give specifics such as a mandatory maintenance schedule, since the user can adjust for local conditions and other parameters the manufacturer did not consider.
- Sam Clowney suggested that more data on good combustion practices could be added to the Good Combustion Practices Document once the engine testing program is complete.
- Mike Milliet stated that for two stroke lean burn engines, a "beta analysis" is often performed in lieu of testing, which checks the pressure balance between the cylinders. It is considered preventative maintenance and is performed two to four times a year. He suggested adding this type of analysis to the Good Combustion Practices Document.
- A Pollution Prevention Subgroup was formed to address the issues of GCPs, operator training, and work practices as a MACT floor. This will be headed by Don Dowdall, and will include Bill Heater, Jay Martin, Don Price, and Sam Clowney as members. Their goal is to provide a white paper to the CC regarding these issues.

Review of Subgroups and Ad-hoc Groups

Amanda Agnew handed out a summary of Subgroups, Ad-Hoc Groups, and Assigned Tasks. This is included as Attachment V. A summary of the revisions to these subgroups is provided below.

Population Subgroup - TASK COMPLETE

The Population Subgroup worked on preliminary MACT floor issues that deal with population data. It was decided that the Population Subgroup has completed its activities. This subgroup has been terminated.

Emissions Subgroup

The Emissions Subgroup is working on MACT issues related to emissions. The Subgroup's tasks:

- Review emissions test data gathered in ICCR database
- Develop list of pollutants and corresponding test methods

- Develop a test plan for future IC engines emissions testing.

Rationale and documentation of each decision should be performed for each task.

Emissions Subgroup Members include Sam Clowney as Chair, Amanda Agnew, Michael Horowitz, Darrell Bowen, Jorge Torres, Don Dowdall, Bill Heater, Bill Passie, Don Price, Bob Stachowicz, Ed Torres, Eric Farrington, Brian Quil, Jay Martin, and Bryan Willson.

The RICE Work Group has six ad-hoc groups to address specific issues:

Diesel Ad-Hoc Group - TASK COMPLETE

The Diesel Ad-Hoc Group reviewed the available options for selection of a diesel unit for testing. It was decided that the Diesel Ad-Hoc Group has completed its activities. This ad-hoc group has been terminated.

Testing Ad-Hoc Group

The Testing Ad-Hoc Group will work on the remaining issues related to emissions testing and coordinate with the EPA contractor for testing. Rationale and documentation of each decision should be performed for each task. Bryan Willson will lead the group. Amanda Agnew, Bob Stachowicz, Jay Martin, Sam Clowney, Don Dowdall, and Darrell Bowen will be members of the group.

Other Fuels Ad-Hoc Group

The Other Fuels Ad-Hoc Group will look at the engines and fuels not covered by the test plan. The group will review the available population and emissions information on those engines and report back to the Emissions Subgroup on the adequacy of the available data and the need for additional emissions testing. The group will also identify the preliminary MACT floor for those engines and fuels. Rationale and documentation of each decision should be performed for each task. Ed Torres will lead the group. Jay Martin, Mike Horowitz and Don Price will be members of the group.

Above the Floor Ad-Hoc Group

The Above the Floor Ad-Hoc Group will review issues identified by the RICE Work Group to move from the MACT floor and test plan to a MACT standard for RICE. Those issues are:

- Define preliminary subcategories (from an emissions standpoint)
- Identify applicable control technologies
- Gather cost information on controls
- Determine size cutoffs
- Finalize definitions of standby, emergency, and peaking units
- Develop model plants
- Determine the population of applicable units
- Perform a cost/benefit analysis
- Estimate national impacts.

Rationale and documentation of each decision should be performed for each task.

Sam Clowney will lead the group. Darrell Bowen, Ed Torres, Bryan Willson, Don Dowdall, Amanda Agnew, Mike Milliet, and Don Price will be members of the group.

New Source MACT Ad-Hoc Group

The New Source MACT Ad-Hoc Group will review issues related to developing a MACT standard for new sources, including determining subcategories. Rationale and documentation of each decision should be performed for each task. Bill Passie will lead the group. Jay Martin, Sam Clowney, Bryan Willson, Bill Walker, Don Dowdall, Mike Horowitz and Mike Brand will be members of the group.

Schedule Ad-Hoc Group

The Schedule Ad-Hoc Group will review the schedule and timeline of the ICCR process, and will make sure the RICE WG is on track. Rationale and documentation of each decision should be performed for each task. Amanda Agnew will lead the group. Bill Passie, Bryan Willson, Sam Clowney, Ed Torres, and Don Dowdall will be members of the group.

Pollution Prevention (P2) Ad-Hoc Group

The Pollution Prevention Ad-Hoc Group will work on the following issues as related to MACT Floor and Above-the-Floor MACT:

- Good combustion practices
- Compliance monitoring and recordkeeping
- Operator training
- Work practices.

Rationale and documentation of each decision should be performed for each task.

Don Dowdall will lead the group. Bill Heater, Sam Clowney, Don Price, and Jay Martin will be members of the group.

Update on Testing Issues

Bryan Willson briefly talked about testing issues, including catalyst vendor selection and catalyst control efficiency. Major points included the following:

Catalyst Vendor Selection

- Two manufacturers have offered to provide catalysts at cost for the testing effort. These are Johnson-Matthey and Miratech. A Testing Subgroup telecon concluded that neither manufacturer is particularly advantageous, at least with known parameters, at this time; Johnson-Matthey is a larger manufacturer, while Miratech is better known for large engine catalyst applications.
- Gas Research Institute and PRC International have agreed to pay for the catalysts.

Catalyst Control Efficiency

- Both manufacturers say that there is not a typical catalyst nor a typical reduction. This must be specified by the RICE WG. The Testing Subgroup must draft a written rationale for the selection of the catalyst's reduction.
- Vick Newsom stated that Texas required 2 grams NOx per bhp-hr for all engines greater than 499 hp in attainment areas for rich and lean burn engines. Typically there are 17 grams NOx per bhp-hr uncontrolled. [*Per a latter conversation with Vick, this efficiency works out to be 88%.*] Furthermore, the average catalyst purchased has an 80% reduction for NOx.
- Don Price stated that for California, for the last 5 or 6 years the NOx reduction requirement was 90%. It recently rose to 96%. He recommends a 90% reduction for NSCR for NOx.
- It was discussed whether or not the RICE WG should specify the highest control efficiency possible for the catalysts. It was noted that the costs increase dramatically while control efficiency percentages rise slowly; therefore, there is a point of diminishing returns. It may not be cost efficient to specify the highest control efficiency possible.

- Bob Stachowicz stated that in his experience, catalyst manufacturers stated a percent reduction for CO and HC also. He suggested the WG stay focused on HAPs and look at HC reduction.
- Mike Milliet suggested utilizing the Emissions Database to identify a location where engines retrofitted with catalysts are installed, identify the required limits, and back calculate to get a reduction efficiency that these engines need to meet.
- Jay Martin suggested that the change in efficiency is based on catalyst volume and exhaust temperature. It would be ideal to investigate cost and conversion rate through the testing program.
- Sam Clowney agreed to contact SW Research for advice on choosing a conversion efficiency.
- Drek Newton suggested looking into state regulations and permits for HAPs for RICE. Brahim Richani stated that this was already investigated, and there are no HAP regulations for RICE for any states at this time.
- Bill Passie suggested a technology based starting point and a "ratcheting down," or increase of efficiency, over time.

Presentation on Cost Calculations for Add-on Controls

Jennifer Snyder made a brief presentation regarding Cost Calculations for Add-on Controls. This presentation is included as Attachment VI. Discussion which followed included the topics listed below:

- Concerns were raised about the estimation of costs by the OAQPS Control Cost Manual and by vendor information. WG members indicated that these estimates appear to be lower than actual costs. WG members were encouraged to submit actual control device installation cost data to EPA.
- WG members inquired about the existence of a limit for cost effectiveness (given in dollars per ton). Mike Horowitz said that averages need to be reviewed, and that there is not a set cutoff per source.

Presentation on Cost/Benefit Analysis for Above-the-Floor MACT

A presentation on Cost/Benefit Analysis for Above-the-Floor MACT was presented by Jennifer Snyder. This is included as Attachment VII. The following were points of discussion:

- A concern was raised about the procedure for determining

which engines in the Population Database are located in major sources.

- Amanda Agnew will look into Section 112(c)(6) regarding area sources.
- Bill Walker suggested that for New Source MACT, both area and major sources should be reviewed.
- It was suggested that the engine function (i.e., pump, electric generation, or compressor) be used in place of SIC.

Presentation of Strawman Model Engines and Development of Preliminary Model Engines

Sam Clowney made a presentation entitled "Model Engines Strawman Proposal." This is included as Attachment VIII. It included a chart of Model Engines which was completed during the discussion period. The attachment presented here includes the engines which were determined during the discussion period. Alpha-Gamma provided a handout identifying the most common engines in the RICE Population Database with the model engine parameters determined by the subgroup. This is included as Attachment IX. Engine manufacturers are requested to review the chosen engines, and fill in any remaining blanks.

Usage and Size Cutoffs for Subcategorization

Alpha-Gamma handed out a summary of emergency generator and size cutoff information. This is included as Attachment X.

- Vick Newsom suggested an emissions cutoff rather than a HP cutoff. He gave an example of a dehydrator having a one ton per year limit on benzene emissions.

SCR for HAP Reduction

Alpha-Gamma provided the two journal articles regarding SCR for HAP reduction which were referenced by Siemens. These were provided for the WG members' review and background information regarding the applicability of SCR to HAP control. These articles are not available electronically; to obtain copies of these two articles, contact Jennifer Snyder at 919-954-0033. The references are:

1) Ludres, H., R. Backes, and G. Huthwoyl from FEV Motorentechnik, and D. Ketcher, R.W. Horrocks, R.G. Hurley, and

R.H. Hammerle from Ford Motor Co. *An Urea Lean NOx Catalyst System for Light Duty Diesel Vehicles.* SAE Technical Paper Series 952493. October 16-19, 1995. Warrendale, PA.

2) Hums, E., M. Joisten, R. Muller, R. Sigling, and H. Spielmann. *Innovative lines of SCR catalysis: NOx reduction for stationary diesel engine exhaust gas and dioxin abatement for waste incineration facilities.* Catalysis Today 27 (1996) 29-34. Elsevier Science B.V. 1996.

Next Meeting Issues

The next meeting will be held on Thursday, July 30, 1998. It will be held at the Renaissance Hotel in Long Beach, California. This meeting is scheduled from 8 a.m. to 3 p.m.

These minutes represent an accurate description of matters discussed and conclusions reached and include a copy of all reports received, issued or approved at the April 30, 1998 meeting of the Reciprocating Internal Combustion Engines WG. Amanda Agnew

ATTACHMENT I

LIST OF ATTENDEES

Stationary Internal Combustion Engines Work Group Meeting
Fort Collins CO
April 30, 1998
List of Attendees

Amanda Agnew	EPA OAQPS Emissions Standards Division
Darrell Bowen	CNG Transmission Corporation
Michael Brand	Cummins Engine Company, Inc.
Sam Clowney	Tenneco Energy
Donald Dowdall	Engine Manufacturers Association
Charles Elder	General Motors Corporation
Bill Heater	Cooper Energy Services
Michael Horowitz	EPA Office of General Counsel
Jay Martin	University of Wisconsin-Madison
Michael Milliet	Texaco E&P Inc.
Vick Newsom	Amoco Production Section
Drek Newton	U.S. Naval Facilities Engineering Service Center
William Passie	Caterpillar, Inc.
Donald Price	Ventura County Air Pollution Control District
Bob Stachowicz	Waukesha Engine Division
Bill Walker	Alaska Department of Environmental Conservation
Bryan Willson	Colorado State University
Jan Connery	Eastern Research Group
Brahim Richani	Alpha-Gamma Technologies
Jennifer Snyder	Alpha-Gamma Technologies
Doug Bell	EPA OAQPS Emissions Standards Division
Stan Coerr	Coerr Environmental
Linda Coerr	Coerr Environmental
Terry Harrison	EPA OAQPS Emissions Measurement Center
Brian Quil	U.S. Naval Facilities Engineering Service Center

Mahesh Gundappa Radian International

Farhana Mohammed	City of Los Angeles, TMPWG
Shirish Shimpi	Engine Manufacturers Association and TMPWG
Mike Whelan	Gas Research Institute
Rich Anderson	Wheelabrator Technologies
Ed Wheless	LA County Sanitation Districts
Ed Repa	NSWMA

ATTACHMENT II

AGENDA FOR THE APRIL 30, 1998 RICE WG MEETING

Tentative Agenda
Reciprocating Internal Combustion Engine Work Group
April 30, 1998 Work Group Meeting
Fort Collins, Colorado

8:00 – 8:15 Welcome, Meeting Goals and Agenda Review (A. Agnew and J. Connery)

MEETING GOALS:

1. Review Subgroups and Ad-Hoc Groups, including goals, work activities, and membership
2. Update on testing issues, including draft work order for catalyst vendor and highlights of meeting with EPA testing contractor
3. Update on P2 -- status of GCP Subgroup and any new recommendations from the Coordinating Committee
4. Develop Preliminary Model Units for the Above-the-Floor Cost-Effectiveness Estimates

8:15 – 8:25 Report on the Coordinating Committee Meeting (V. Newsom)

8:25 – 8:45 Update on P2 Activities (D. Dowdall and S. Clowney)

8:45 – 9:05 Other Fuel MACT Floor Issues (Alpha-Gamma)

9:05 – 9:25 Review of Subgroups & Ad-Hoc Groups (A. Agnew)

9:25 – 9:35 BREAK

9:35 – 10:25 Update on Testing Issues (B. Wilson)

10:25 – 11:25 Tour of the Engine and Energy Conversion Laboratory (B. Wilson)

11:25 – Noon LUNCH

Noon – 12:20 Presentation on Cost of Add-on Controls (Alpha-Gamma)

1. Breakdown of Cost Categories Considered
2. Anticipated source of information
3. Assumptions needed

12:20 – 1:00 Work Group Discussion of Cost-Effectiveness for Above-the-Floor MACT (S. Clowney)

1:00 – 1:35 Presentation on the use of Model Units & Criteria for Development of Model Engines (results from last mtg) (Alpha-Gamma)

1:35 – 1:45 BREAK

1:45 – 2:05 Presentation of Strawman Model Engines (S. Clowney)

2:05 – 2:50 Work Group Discussion of Strawman & Development of Preliminary Model Engines (S. Clowney)

2:50 -- 3:00 Next Meeting and Flash Minutes (J. Connery and Alpha-Gamma)

3:00 ADJOURN

ATTACHMENT III

BULLET POINT SUMMARY

Summary of ICCR Source Work Group Meeting, April 30, 1998
Internal Combustion Engines Work Group Meeting
Engines and Energy Conversion Lab, Fort Collins, Colorado

Decisions

- The preliminary MACT floor for the Landfill/Digester Gas subcategory is no add-on controls.

Next Meeting

- The next meeting will be in Long Beach, California following the CC Meeting, on July 30, 1998. It will be held in the Renaissance Long Beach Hotel. This meeting is scheduled from 8 a.m. to 3 p.m.
- Reservations for this hotel can be made by calling 562-437-5900 by June 26. To receive the discount rate, mention the "EPA ICCR Meeting."

Action Items

- Other Fuels Subgroup: Obtain database of landfill gas engines from Ed Wheles of LACSD.
- Don Price: Research violations on landfill gas engines with air injection as a control device.
- Bryan Willson: Provide engineering writeup of rationale for inapplicability of air injection to HAP control.
- Alpha-Gamma: Remove flaring from landfill gas engines (nonsense control device).
- Don Dowdall: Provide Good Combustion Practices writeup to RICE WG.
- Sam Clowney: Contact SW Research for catalyst specification advice.
- Testing Subgroup: Conference call to decide on catalyst specifications.
- RICE WG: Provide actual cost data to Alpha-Gamma regarding catalyst installation.
- Alpha-Gamma: Write up a Preliminary MACT Floor Rationale.
- EPA: Investigate the impact of 112(c)(6) regarding area sources.
- EPA: Develop a list of subgroups, members, tasks and dates.
- EPA: Write up the list of model engines developed by the RICE WG and circulate it for completion.

ATTACHMENT IV

LANDFILL / DIGESTER GAS PRELIMINARY MACT FLOOR

Landfill / Digester Gas Preliminary MACT Floor

Presented to:
RICE WG
Fort Collins, Colorado

Presented by:
Brahim Richani
Alpha-Gamma Technologies, Inc.

April 30, 1998

1

Landfill / Digester Gas Subcategory

- Representation in Population Database: 174 engines
- Controls summary:
  - Air injection 7% (10 engines)
  - Staged combustion 2%
  - Flaring 2%
  - Gas scrubber 1%
  - Miscellaneous 1%

2

Air Injection Control Procedure

- Reduces NO_X by operating at 10% excess fuel (ultra-rich firing)
- Reduces CO by injecting air into the exhaust stream
  - Reduction by oxidation: Introduces O_2 to an exhaust stream at 1200 to 1300 F and 2% CO
  - CO oxidizes to CO_2
  - Technologically similar to "Smog Pump"

3

Conclusions

- Preliminary MACT Floor:

  Air injection for ultra-rich burn engines firing landfill or digester gas
- CAUTION:
  - Equipment constructed in-house as a temporary fix (not readily available equipment)
  - Applicable to ultra-rich burn engines operating at 80 to 100% load
  - AMSA Data indicate more than 350 landfill and digester gas engines with no add-on controls

4

ATTACHMENT V

RICE WG SUBGROUPS, AD-HOC GROUPS, AND ASSIGNED TASKS

RICE WORK GROUP

Subgroups, Ad-Hoc Groups, and Assigned Tasks

The **RICE Work Group** has **two Subgroups:** Population and Emissions

The **Population Subgroup** is working on preliminary MACT-floor issues that deal with population data. The Subgroup's tasks:

1. Review and enhance EPA population data for IC engines.
2. Use data to determine subcategories, control devices, model plants, and MACT floor. Population Subgroup Members:

Mike Millet, Texaco, **Chair**
Amanda Agnew, EPA
Mike Horowitz, EPA, Office of General Counsel
Vick Newsom, Amoco
Sam Clowney, Tennessee Gas Pipeline
Randy Hamilton, Texas Natural Resource Conservation Commission (TNRCC)
Bill Walker, Alaska Department of Environmental Conservation
Bryan Wilson, Colorado State University

The **Emissions Subgroup** is working on MACT issues related to emissions. The Subgroup's tasks:

1. Review emissions test data gathered in ICCR database.
2. Develop list of pollutants and corresponding test methods.
3. Develop a test plan for future IC engines emissions testing. Emissions Subgroup Members:

Sam Clowney, Tennessee Gas Pipeline, **Chair**
Amanda Agnew, EPA
Michael Horowitz, EPA, Office of General Counsel
Darrell Bowen, CNG Transmission Corporation
Jorge Torres, Natural Gas Pipeline of America
Don Dowdall, Consultant to the Engine Manufacturers Association
Bill Heater, Cooper Energy Services
Bill Passie, Caterpillar, Inc.
Don Price, Ventura County Air Pollution Control District (California)
Bob Stachowicz, Waukesha Engine Division
Ed Torres, Orange County Sanitation District (California)
Eric Farrington, Metro Wastewater Reclamation District
Brian Quil, U.S. Naval Facilities Engineering Service Center
Jay Martin, University of Wisconsin-Madison
Bryan Willson, Colorado State University

The **RICE WORK Group** has six Ad-Hoc groups to address specific issues:

Diesel Ad-Hoc Group - COMPLETE

The Diesel Ad-Hoc Group will review the available options for selection of a diesel unit for testing. Don Dowdall will lead the group. Bryan Willson, Jay Martin, and Mike Brand or Bill Passie will be members of the group.

Testing Ad-Hoc Group

The Testing Ad-Hoc Group will work on the remaining issues related to emissions testing and coordinate with the EPA contractor for testing. Bryan Willson will lead the group. Amanda Agnew, Bob Stachowicz, Jay Martin, Sam Clowney, Don Dowdall, and Darrell Bowen will be members of the group.

Other Fuels Ad-Hoc Group

The Other Fuels Ad-Hoc Group will look at the engines and fuels not covered by the test plan. The group will review the available population and emissions information on those engines and report back to the Emissions Subgroup on the adequacy of the available data and the need for additional emissions testing. The group also will work with the Population Subgroup on the preliminary MACT floor for those engines and fuels. Ed Torres will lead the group. Jay Martin will be a member of the group.

Above the Floor Ad-Hoc Group

The Above the Floor Ad-Hoc Group will review issues identified by the RICE Work Group to move from the MACT floor and test plan to a MACT standard for RICE. Those issues are:

1. Define preliminary subcategories (from an emissions standpoint)
2. Identify applicable control technologies
3. Gather cost information on controls
4. Develop model plants Sam Clowney will lead the group. Darrell Bowen, Ed Torres, Bryan Willson, Don Dowdall, Amanda Agnew, and Don Price will be members of the group.

New Source MACT Ad-Hoc Group

The New Source MACT Ad-Hoc Group will review issues related to developing a MACT standard for New Sources. Bill Passie will lead the group.

Schedule Ad-Hoc Group

The Schedule Ad-Hoc Group will review schedule and time line of ICCR process, make sure group is on track. Amanda Agnew will lead the group. Bill Passie, Bryan Willson, Sam Clowney, Ed Torres, and Mike Millet will be members of the group.

ATTACHMENT VI

CONTROL DEVICE COST EFFECTIVENESS CALCULATIONS

Control Device Cost Effectiveness Calculations

Presented to:
RICE WG
Fort Collins, Colorado

Presented by:
Jennifer Snyder
Alpha-Gamma Technologies, Inc.

April 30, 1998

1

Control Costs

Utilize *OAQPS Control Cost Manual* methodology to determine:

- Total Capital Costs
- Total Annual Costs
- Cost Effectiveness

2

Total Capital Cost Components and Factors

- Total Capital Cost (TCC) =
  Direct Costs (DC) + Indirect Costs (IC)

3

Direct Costs (DC): DC=PEC + DIC

– Purchased Equipment Costs (PEC)
  - Control Device and auxiliary equipment (EC)
  - Instrumentation (10% of EC)
  - Sales Tax (3% of EC)
  - Freight (5% of EC)

– Direct Installation Costs (DIC)
  - Foundations and Supports (8% of PEC)
  - Handling and Erection (14% of PEC)
  - Electrical (4% of PEC)
  - Piping (2% of PEC)
  - Insulation for Ductwork (1% of PEC)
  - Painting (1% of PEC)

4

Indirect Costs (IC): IC = IIC + C

- Indirect Installation Costs (IIC)
  - Engineering (10% of PEC)
  - Construction and Field Expenses (5% of PEC)
  - Contractor Fees (10% of PEC)
  - Start-up (2% of PEC)
  - Performance Test (1% of PEC)
- Contingencies (C) (3% of PEC)
  - Equipment Redesign and Modifications
  - Cost Escalations
  - Delays in Startup

5

Total Annual Cost Elements and Factors

- Total Annual Cost (TAC) =
  Direct Annual Costs (DC) +
  Indirect Annual Costs (IC)

6

Direct Annual Costs

- Utilities
- Operating Labor
- Maintenance
- Annual Compliance Test
- Catalyst Cleaning
- Catalyst Replacement
- Catalyst Disposal

7

Indirect Annual Costs

- Overhead (.60*Operating labor and maintenance costs)
- Fuel Penalty
- Property Tax (1% of TCC)
- Insurance (1% of TCC)
- Administrative Charges (2% of TCC)
- Capital Recovery $((i(1+i)^n/(1+i)^n-1)*TCC)$ where i is the interest rate, and n is the equipment life

8

Cost Effectiveness

- Measured in $/ton of pollutant removed
- Divide total annual cost by the annual tons of pollutant removed

ATTACHMENT VII

RICE COST/BENEFIT ANALYSIS

RECIPROCATING INTERNAL COMBUSTION ENGINES COST/BENEFIT ANALYSIS

Presented to:
RICE Work Group
Fort Collins, Colorado

Presented by:
Jennifer Snyder
Alpha-Gamma Technologies, Inc.

April 30, 1998

1

OBJECTIVES

- Estimate nationwide emissions reduction
- Estimate capital and annual costs of control devices
- Determine cost effectiveness and emission reduction benefits

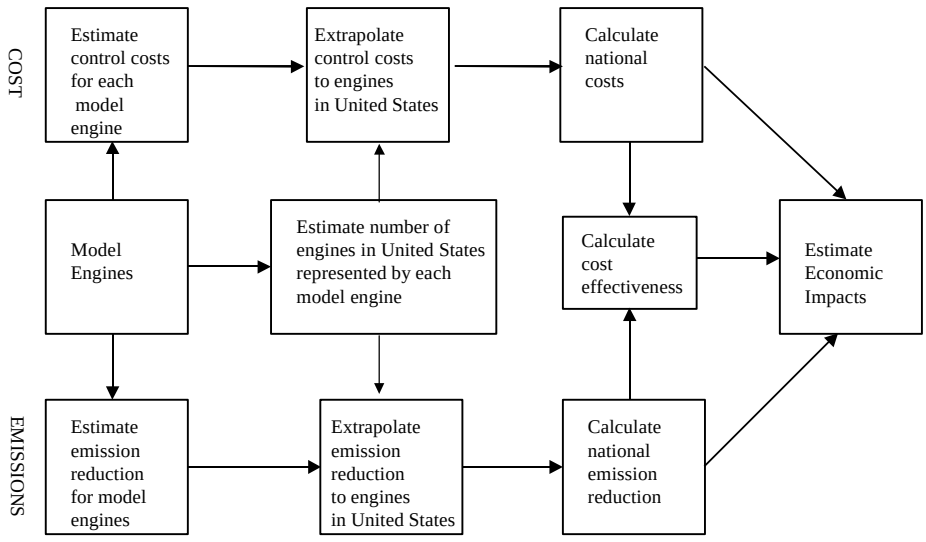
2

APPROACH

- Identify a representative set of engines (model engines)
- Estimate nationwide population represented by each model engine
- Estimate emission reduction and cost of control for each model engine
- Extrapolate emission reductions and costs to determine national impacts

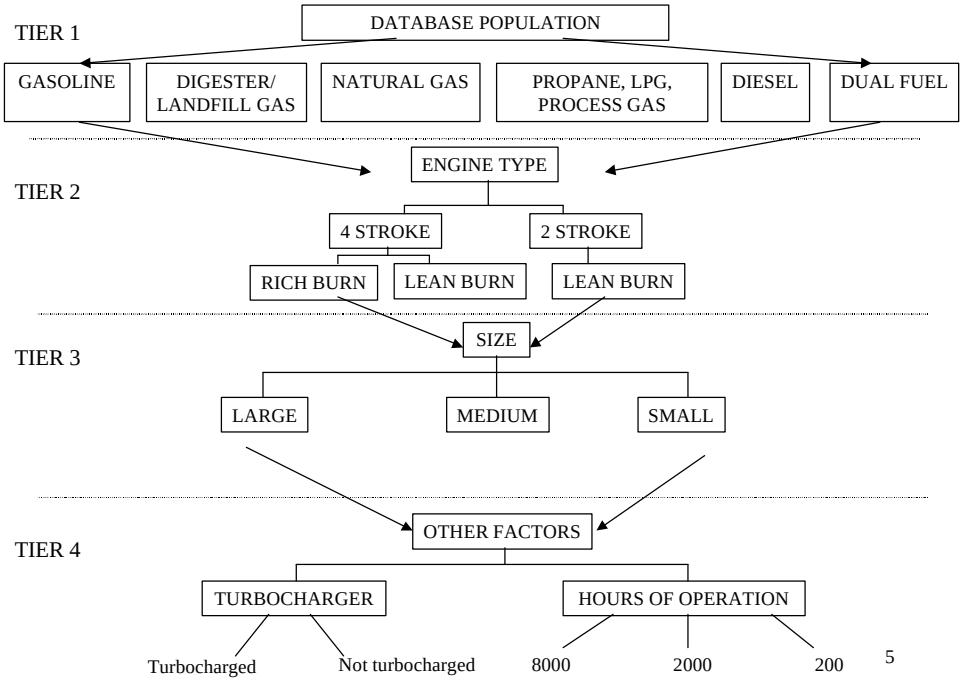
3

MODEL ENGINE DEVELOPMENT - BIG PICTURE



4

MODEL ENGINE ASSIGNMENT PROTOCOL



5

MODEL ENGINES STRAWMAN

ENGINE TYPE	HP RANGE	HOURS OF OPERATION	POSS TURBOC
SIGF 2SLB	100-1000	2000	Y
	1000-5000	8000	Y
	5000-10000	8000	Y
CILF 2SLB	80-200	200,2000	Y
	200-2000	200,2000,8000	Y
SIGF 4SRB	20-300	2000	Y
	300-2000	2000,8000	Y
SILF 4SRB	1-20	200,2000	N
	20-200	200,2000	N
SIGF 4SLB	200-1000	2000	Y
	1000-6000	2000,8000	Y
CILF 4SLB	20-100	200,2000	Y

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EXTRAPOLATE NATIONWIDE POPULATION OF ENGINES

- Determine the engine distribution within each industry
- Obtain WG expert input
- Apply distribution to total units within each industry

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EXTRAPOLATE NATIONWIDE POPULATION OF ENGINES

SIC	# of Units in Pop. DB	# of Units with Known Parameters	Model Unit 1	Model Unit 2	Model Unit 3	Model Unit …	Model Unit …	Model Unit 4
1234	10200	200	120	50	30			10

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NEXT STEPS

- Establish teams to refine this approach
- Develop database queries to generate distributions for parameters in the population database (e.g., size, operating hours, etc.)
- Establish the total number of engines nationwide

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ATTACHMENT VIII

MODEL ENGINES STRAWMAN PROPOSAL

Model Engines
Strawman Proposal

Presented to:

IC Engine Work Group

April 30,1998

Presented by:

Sam Clowney, Tennessee Gas Pipeline
on behalf of the Above-the-Floor Ad Hoc Group

Above-the-Floor Ad Hoc Group

- Sam Clowney, Chair
- Amanda Agnew
- Darrell Bowen
- Don Dowdall
- Don Price
- Ed Torres
- Bryan Willson

Criteria

1. Does the engine characteristic affect HAP emissions on a ton per year basis?
2. Does the engine characteristic affect control device efficiency?
3. Does the engine characteristic affect costs to add on controls?

Engine Characteristics

- Characteristics that Meet 3 Criteria:
  - Subcategories (affects emissions & efficiency)
  - Size (affects emissions and costs)
    - » Choose break points that correspond to technological differences
  - Hours of Operation (affects emissions)
    - » Use 3 categories: 200, 2000, & 8000 hours
  - Presence of Turbocharger (affects costs)

APRIL 30 RICE WG DRAFT MODEL ENGINES STRAWMAN

ENGINE TYPE	HP RANGE	ANNUAL HOURS OF OPERATION	TURBOCHARGED	TYPICAL ENGINE FROM POPULATION DATABASE
SIGF 2SLB	100-1,000	2000	YES	
			NO	CLARK HRA
	1,000-5,000	8000	YES	CLARK TLA-6
			NO	CLARK HBA-5
	5,000-10,000	8000	YES	CLARK TCV-16
			NO	
CILF 2SLB	80-200	200	YES	
			NO	
		2000	YES	
			NO	
	200-2,000	200	YES	DETROIT 8V92 TA
			NO	DETROIT 8V92N
		2000	YES	DETROIT 8V92 TA
			NO	DETROIT 8V92N
		8000	YES	DETROIT 8V92 TA
			NO	DETROIT 8V92N
SIGF 4SRB	20-300	200	YES	CUMMINS CNGC GTA 8.3
			NO	WAUKESHA F18G
	20-300	2000	YES	CUMMINS CNGC GTA 5.9
			NO	CUMMINS CNGC G 5.9
	300-2,000	200	YES	CUMMINS CNGC GTA 19
			NO	WAUKESHA H24G
		2000	YES	CUMMINS CNGC GTA 19
			NO	WAUKESHA L7042G
		8000	YES	CATERPILLAR 3508
			NO	CATERPILLAR G399

ENGINE TYPE	HP RANGE	ANNUAL HOURS OF OPERATION	TURBOCHARGED	TYPICAL ENGINE FROM POPULATION DATABASE
SILF 4SRB	1-20	200	NO	
		2000	NO	
	20-200	200	NO	
		2000	NO	
SIGF 4SLB	200-1,000	2000	YES	CATERPILLAR 3412
			NO	
	1,000-6,000	2000	YES	CATERPILLAR 3512
			NO	
		8000	YES	CATERPILLAR 3512
			NO	
CILF 4SLB	20-100	200	YES	CATERPILLAR 3304T
			NO	CATERPILLAR 3304NA
		2000	YES	CATERPILLAR 3304T
			NO	CATERPILLAR 3304NA
	100-8,500	200	YES	CATERPILLAR 3606T
			NO	CATERPILLAR 3606NA
		2000	YES	CATERPILLAR D399
			NO	CATERPILLAR D399
		8000	YES	CATERPILLAR D399
			NO	CATERPILLAR D399

ATTACHMENT IX

MODEL ENGINES IDENTIFIED IN THE RICE POPULATION DATABASE

POPULATION DATABASE MODEL ENGINES STRAWMAN

ENGINE TYPE	HP RANGE	ANNUAL HOURS OF OPERATION	TURBOCHARGED	TYPICAL ENGINE FROM POPULATION DATABASE
SIGF 2SLB	100-1,000	2000	YES	NONE AVAILABLE
			NO	CLARK TLA-6 CLARK RA-6 AJAX DPC 720LE AJAX DPC360LE
	1,000-5,000	8000	YES	COOPER BESSEMER 10V250
			NO	CLARK BA6 CLARK HRA-8 COOPER BESSEMER GMV10
	5,000-10,000	8000	YES	NONE AVAILABLE
			NO	CLARK BA8 CLARK HLA-8 CLARK TCVC-20 COOPER BESSEMER 12W330
CILF 2SLB	80-200	200	YES	NONE AVAILABLE
			NO	GM 8-268A
		2000	YES	NONE AVAILABLE
			NO	NONE AVAILABLE
	200-2,000	200	YES	NONE AVAILABLE
			NO	DETROIT 8V92N
		2000	YES	NONE AVAILABLE
			NO	DETROIT 16V71 DETROIT 8VA
		8000	YES	NONE AVAILABLE
			NO	DETROIT 16V71

ENGINE TYPE	HP RANGE	ANNUAL HOURS OF OPERATION	TURBOCHARGED	TYPICAL ENGINE FROM POPULATION DATABASE
SIGF 4SRB	20-300	2000	YES	NONE AVAILABLE
			NO	WAUKESHA 180 GVBU CATERPILLAR G342 WAUKESHA VRG220 WAUKESHA 817
	300-2,000	2000	YES	CATERPILLAR 398
			NO	CATERPILLAR 399 WAUKESHA 7042GSI WAUKESHA L7042GU WHITE SUPERIOR 8G825
		8000	YES	CATERPILLAR G398
			NO	WAUKESHA 7042GSI WAUKESHA L7042GU WHITE SUPERIOR 8G825
SILF 4SRB	1-20	200	NO	NONE AVAILABLE
		2000	NO	NONE AVAILABLE
	20-200	200	NO	NONE AVAILABLE
		2000	NO	NONE AVAILABLE
SIGF 4SLB	200-1,000	2000	YES	CATERPILLAR 3412 CATERPILLAR D398
			NO	WORTHINGTON UTC-166 CATERPILLAR 3306 CATERPILLAR 399TAA
	1,000-6,000	2000	YES	CATERPILLAR 3516
			NO	WAUKESHA 7042 GL WHITE SUPERIOR 8GTL WORTHINGTON SUTC-168
		8000	YES	COOPER BESSEMER LSV16SG INGERSOLL RAND 412KVS WHITE SUPERIOR 16SGTB WHITE SUPERIOR 8GTL825
			NO	WAUKESHA 7042GL

ENGINE TYPE	HP RANGE	ANNUAL HOURS OF OPERATION	TURBOCHARGED	TYPICAL ENGINE FROM POPULATION DATABASE
CILF 4SLB	20-100	200	YES	NONE AVAILABLE
			NO	NONE AVAILABLE
		2000	YES	NONE AVAILABLE
			NO	CATERPILLAR 3304 CATERPILLAR D330A DEUTZ F4L912
	100-8,500	200	YES	CATERPILLAR 3512 CATERPILLAR D349 CATERPILLAR D398 CATERPILLAR D399
			NO	CUMMINS KTA-3067-GS
		2000	YES	CATERPILLAR 3412 CATERPILLAR D399
			NO	CATERPILLAR 3406 CATERPILLAR D353
		8000	YES	CATERPILLAR 3412 CATERPILLAR 3512 CATERPILLAR 3516
			NO	CATERPILLAR 3406 WAUKESHA 7042GL

ATTACHMENT X

MEMORANDUM REGARDING FURTHER SUBCATEGORIZATION BASED ON SIZE AND USAGE

MEMORANDUM

To: Engines Work Group
From: Jennifer Snyder and Brahim Richani
Subject: Further Subcategorization based on Size and Usage
Date: April 30, 1998

Alpha-Gamma reviewed the HP breakdowns in further subcategorizing 4 stroke rich burn engines. In analyzing the data given in the Population Database, for engines with data on HP which were categorized as 4 stroke rich burn engines, the following cuts can be made in the database.

0-250 HP 6.2% catalytic reduction
>250 HP 27.5% catalytic reduction

0-475 HP 11.2% catalytic reduction
>475 HP 29.0% catalytic reduction

0-500 HP 11.5% catalytic reduction
>500 HP 29.2% catalytic reduction

The following ranges were also examined:

251-499 HP 22% catalytic reduction
101-250 HP 10% catalytic reduction
0-100 HP 1% catalytic reduction

The data show that the cutoff should be made at 250, rather than at 475 or 500 HP.

Alpha-Gamma has also been researching the possibility of a separate subcategory for emergency generators. These would be potentially separated from the rest of the engines by a branch on the subcategory tree near the top, separate from spark and compression ignition. The following numbers were found:
(Indentions indicate levels of branches from the tree; note that emergency generators are branched directly from the population of stationary engines, as are compression and spark ignition. This is not the only way these can be branched, but for simplicity's sake, it's a good starting point.)

Engines: 28143
- Emergency Generators: 4705
- Compression Ignition: 5768
  - Liquid Fuel: 5265
  - Dual Fuel: 503
- Spark Ignition: 17635
  - Liquid Fuel: 338

Gaseous Fuel: 17303
Digester/Landfill Gas: 155
Propane, LPG, Process: 160
Natural Gas: 17014
4 Stroke Rich Burn: 1492
4 Stroke Lean Burn: 975
2 Stroke Lean Burn: 1220

The query that pulled these emergency generators included the following searches:

In the Combustor Description Field:

Like "*emrg*"
Like "*emer*" And Not Like "*bessemer*"

In the Hours of Operation Field:

<200 And Not Like 0.

Standby and peaking units were not included in the query, since these units are probably utilized more than 200 hours per year. (peak hours of electricity use).

The proposed definitions on which industry representatives had a chance to comment includes a definition for “emergency standby engines.” “Emergency standby engine means any stationary internal combustion engine which operates as a mechanical or electrical power source only when the primary power source for a facility has been rendered inoperable in an emergency situation.” AMSA made the only comment, to the effect that emergency engines must be regularly exercised to ensure their operability, and that these engines must have the flexibility to operate whenever there is a fuel or energy shortage, or when the primary power source is unreliable. The original definitions were taken from the 1979 NPRM on stationary engines, ref. 44 FR43171, section 60.321.